MINE WATER UTILIZATION IN THE BAUXITE MINES IN COUNTY FEJÉR

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Bauxite Mines in county Fejér
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SUMMARY

A brief account is given on passive-preventive and active water control in deep bauxite mines in county Fejér. Increasing bauxite production has required the mining of bauxite layers more and more below the original karstic water level. As a result, a reevaluation of water control by passive-preventive modes was in order. This paper considers the following points:
- the impact of active water control on bauxite production and advanced technical equipment;
- the effectiveness of active water control in preventing the greatest mining hazard in the region, the unexpected water inrushes;
- the necessity of the conjunctive use of regional and local dewatering;
- the impact of increasing withdrawals on the water-supply of neighbouring settlements. Original water-supply had to be substituted by withdrawn mine water and special waterworks had to be constructed.

MINE WATER CONTROL AND ITS IMPACT ON THE REGIONAL WATER BUDGET

In the Kincsesbánya region, bauxite production started in 1941. Bauxite resources above the karstic water level had gradually depleted, thus exploration and mining under the karstic water level have been effected. Exploration roadways under the original karstic water level of 175 m A.s.l. were driven either in the overlying rock or the bauxite. When mining started there was no possibility to avoid the confined dolomite aquifer owing to the complicated and fractured geological structure, the uneven dolomite surface and mining technology. Consequently, the first greater inrush occuring as early as in 1948 initiated a fighting period against the greatest regional mining hazard, the water.

Regular pumping started in 1949, and has increased as mining level became deeper and a greater part of the aquifer were influenced. In 1953, production, also from the József mine adjacent to the Kincses mine, was effected below the karstic water level. However, passive control used in the fifties did not make possible to dewater mineable bauxite resources. This control method affected the karstic water budget only slightly, though some decrease was observed in the water levels and discharges of neighbouring springs and wells. Growing bauxite requirement and the applicability of advanced mining technology called for a water control method permitting "dry-state" mining. This method, the active dewatering has been used since 1958 by drainage roadways driven exclusively in the underlying rock. Drawdown is modified, if necessary, by drainage drillings in the dolomite aquifer, leading to considerable increase of the ratio of drinking-quality water.

Active dewatering was planned for mining areas Iszka II, József III, Rákhegy II and Bitó II.

Active dewatering has strongly affected the flow of springs, leading to water-supply problems.

The increase of withdrawal from 7 to 13 m^3/min by 1965 resulted in more intensive water level sinking.

As drawdown area has been spreading, flow of some neighbouring springs /Meluzina, Duzzogó, Forrófő, Csór/ stopped, discharge from the karstic shaft of the Inota Power Station decreased and some wells dried out. Karstic water level started to drop even more rapidly when production in the mine József III started, requiring a total withdrawal amount of 47 m^3/min in 1968. The average radius of the cone of depression became as large as 7 km.

In order to mine deepest regional bauxite resources, investment of Rákhegy II was initiated in 1968. This dewatering system consists of water shafts, drainage roadways driven in the dolomite in a length of 3 km, and a sediment settling basin. Drainage flow was maximum 53 m^3/min of drinking-quality in 1975. The system operated independently from the mine, and was connected with the areas Rákhegy II and Bito II by a tunnel driven in the dolomite. Drained water of drinking quality from both areas is conveyed to the water shafts, pumped to the surface and utilized through a regional water works /Fig. 1./.

However, exploration roadways of Bito II have drained unexpectedly warm water of 22-38 °C, posing problems to both mining and water utilization. The average temperature of the discharge 31,6 m^3/min for the first half of 1981 in Bitó II was 32 °C. A part, 18.2 m^3/min from this amount was utilized, increasing the temperature of drinking water supply from 16 to 20°C.

During the last 20 years 600 x 10^6 m^3 water has been withdrawn, leading to a maximum drop of 260 m and a drawdown area of 450 km^2. The average radius of the zone of depression is 12 km, with radii of 17 km in NE-SW and 14 km transversaly.

The Kincsesbánya dewatering affects adjacent mining areas such as Várpalota and Balinka. In NE direction the zone of depression reaches that of the Tatabánya mining dewatering.

DEWATERING TECHNOLOGY, WATER UTILIZATION AND MANAGEMENT

An economic technological system of great reliability had to be developed in order to pump the great amount of mine water drained as a result of active dewatering. The best type of pumps for this purpose - among all the others - is the submersible pump. Its greatest advantage, as contrast to traditional centrifugal pumps, is its resistance against water and it can be installed from a higher and dry place. The corresponding pipe network requires support only on the surface or a higher part of the shaft. Thus, it can always be installed, even in the case of a flooded mine. Its economic performance is better - efficiency is more than 70 %, referring to the aggregate - and it can be automated in a simple way. Also it does not cause any water pollution /Fig. 2./.

Earlier, safety regulations governed pumping requirements, such as the number and available capacity of pumps. The single condition to be satisfied was to guarantee the pumping of the maximum amount of mine water. However, this condition affected not only the capacity of pumps but the necessary systems of pumping wells and pipes, the safe energy supply and operational control, automation. Such a submergible pump system is the technological basis of active dewatering /Fig. 3./.

There are several alternatives of the whole dewatering system.

If the area to be dewatered is several tens of square kilometres, separate pumping stations installed on drilled wells are the most appropriate. In this case, a prescribed water level can be obtained by programmed withdrawals. Pumped water to be utilized will be collected on the surface. In our present case, however, such a dewatering system is not appropriate since bauxite can be found in lenses.

If the area to be dewatered is smaller, say some square kilometres, it is better to use a central pumping station, where economy in scale is evident. Water level can be sunk by the help of drainage roadways and boreholes. The main pumping station collects water through roadways and pipes. A programmed water level dropping cannot be achieved by the number of pumps, especially if there is direct or indirect hydraulic communication among underground openings used to drainage or conveyance. Water drained at various levels is directed gravitationally to the deepest level, or multi-step pumping is effected. In the former case, a high-capacity pumping station of higher efficiency can be constructed, but some energy loss occurs. It is an economic question to investigate the utilization of this gravitationally lost energy /Fig. 4./.

On the other hand, multi-step pumping efficiency and its reliability is much lower.

Dewatering system of the Fejér-megye Bauxite Mining Company applies the former mode for drinking water pumping and the latter one for polluted mine water pumping.

This partition can be attributed also to the fact that pumping of polluted mine water started at higher levels, and gradually reached lower ones. Thus gradual capacity expansion has been connected always to an existing system. At the same time, drinking water withdrawal was initially planned to be based on a central pumping station at the lowest level.

This pumping system operated initially exclusively for mining purposes has become the base of a regional water-supply system. Both stability and high-level technology of this system contribute to safe water-supply. The underground pumping system is strongly connected to the regional water distribution and utilization systems including also the necessary elements of treatment.

This is the way how the complex regional waterworks has been developed at Kincsesbánya.

Thus, requirements facing the mine water control system have increased since it must perform water-supply for some 100.000 people and industrial plants of special national importance.

It has become of paramount significance to preserve water quality even at the price of extra costs. A closed system must be established with proper sediment settling, and the rate of withdrawal must be harmonized with consumers demand since there is no major storage reservoir in the system. Safety of operation is just as important from the point of consumers as from the point of mine water control.

These conditions can be met only on the basis of joint interest since they exert often a negativ economic effect for the mining company. An example is that peaks of water demand and electric energy demand coincide. As a result, this water demand can be satisfied by using expensive peak energy. This is adverse for the mining company, but drinking water supply may have high national priority.

It is natural that pumped water will be lost if there is no demand and storage possibility. This might be a major national loss since clean water is a growing asset.

Consequently, the use of clean water must be economised and supply cost minimized.

This complex process of mine water utilization has successfully been operating in Fejér county. Namely, the mining company produces and the Regional Waterworks distributes and controls water. Among the greatest consumers are the drinking and industrial supply of the city Székesfehérvár, the industrial supply of the Pét Nitrogen Works and the November 7 Power Station and drinking supply of neighbouring settlements.

Though the efficient operation and the satisfaction of the dual objectives of the system is basically achieved, further development is necessary along the following lines:

- Mine water drainage must be controlled in order to maximize the ratio of drinking-quality water.

- A full utilization of pumped, drinking-quality mine water is to be attained.

- Losses should be minimized, especially of drinking-quality water. This requires optimal storage capacity also in order to decrease peak energy demand and to increase system's economics.

- An appropriate incentive system is necessary, accounting for national, producer's, distributor's and consumer's interests.

- Utilization of warm mine water seems to be useful through separate withdrawal, thermal energy extraction and return to the system. There are three possibilities, and the combinations thereof, for such utilization: sport, agriculture and heating.

The Fejér-county Bauxite Mining Company has possessed two decades of experience on active dewatering. During this period the technological system necessary for a proper satisfaction of the objectives, has been developed. However, not all the possibilities are fully employed yet for mine-water utilization and water management. This holds for water saving, the preservation of clean water and supply economics.

The reason is not only the frequent lack of financial means, but also the human effect regarding this activity of secondary or even tertiary importance.

Present developments and future expectations tend to reflect a higher and higher value of good-quality karstic water as drinking water. Consequently, proper management with this asset is becoming a "must".

List of Figures:

RÁKHEGY II. VIZBÁZIS
IVÓVIZELOSZLÁSI VÁZLAT

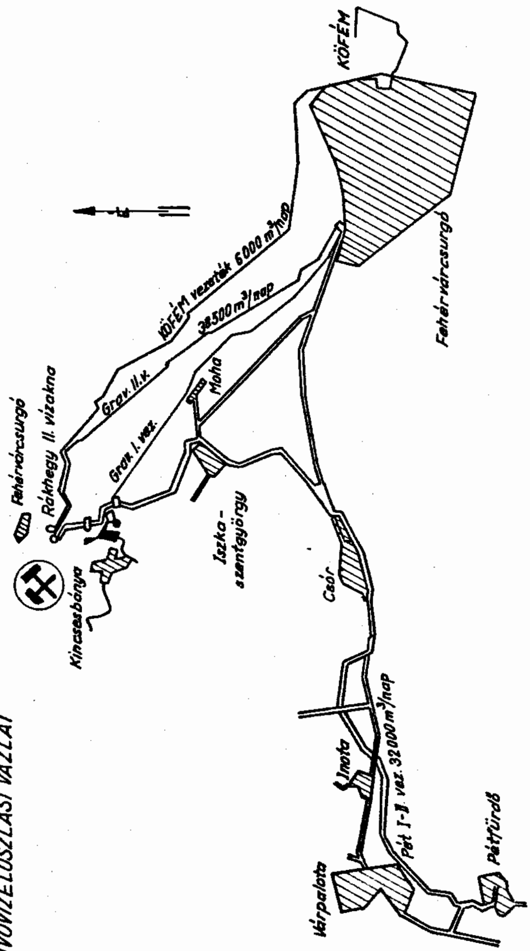

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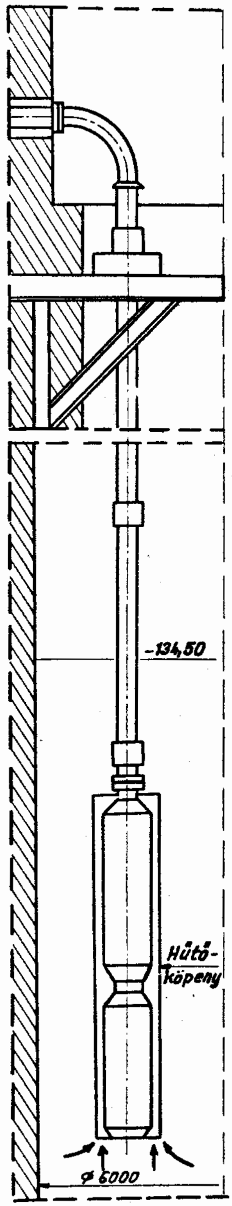
Fig. 1.

BÚVÁRSZIVATTYÚ BEÉPITÉS



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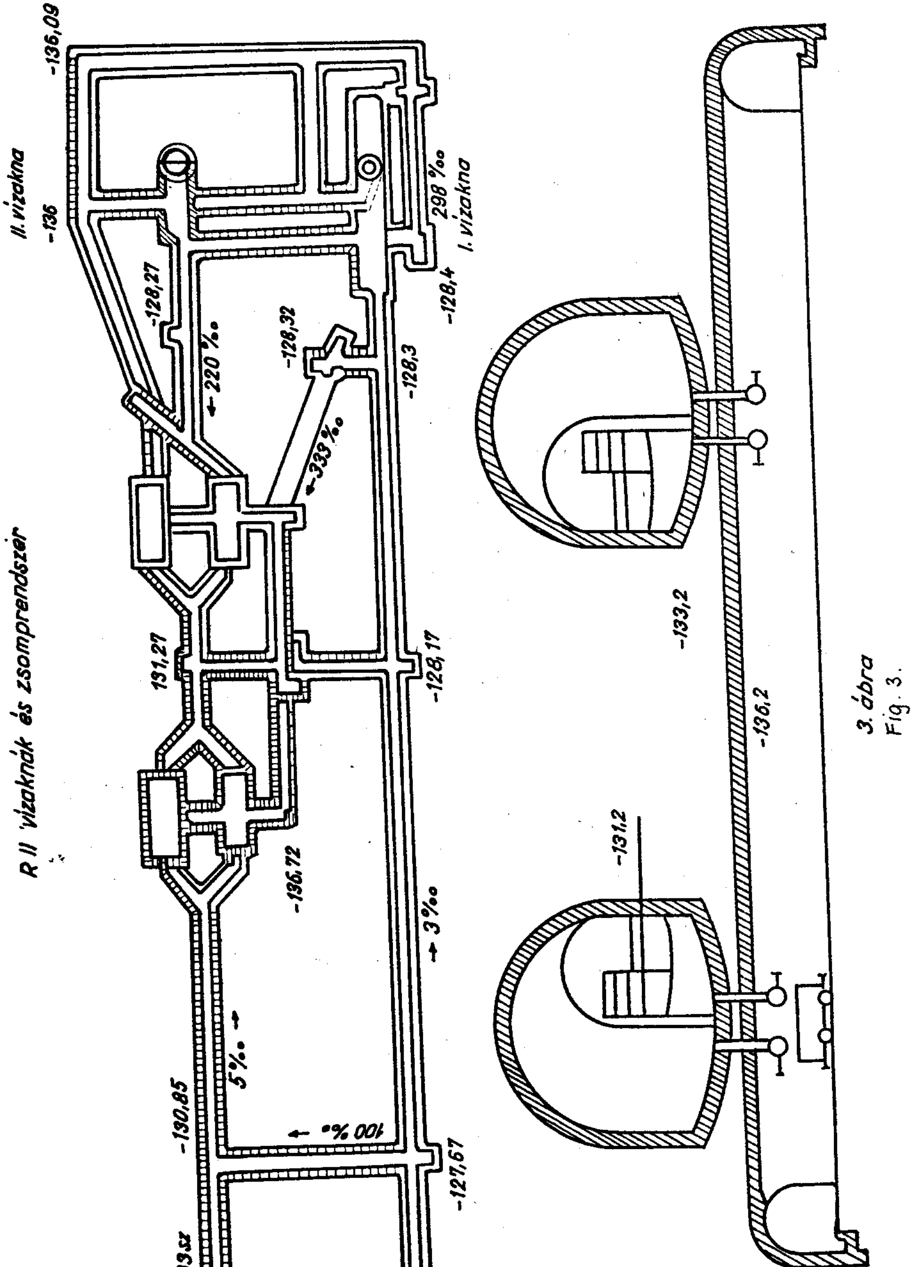
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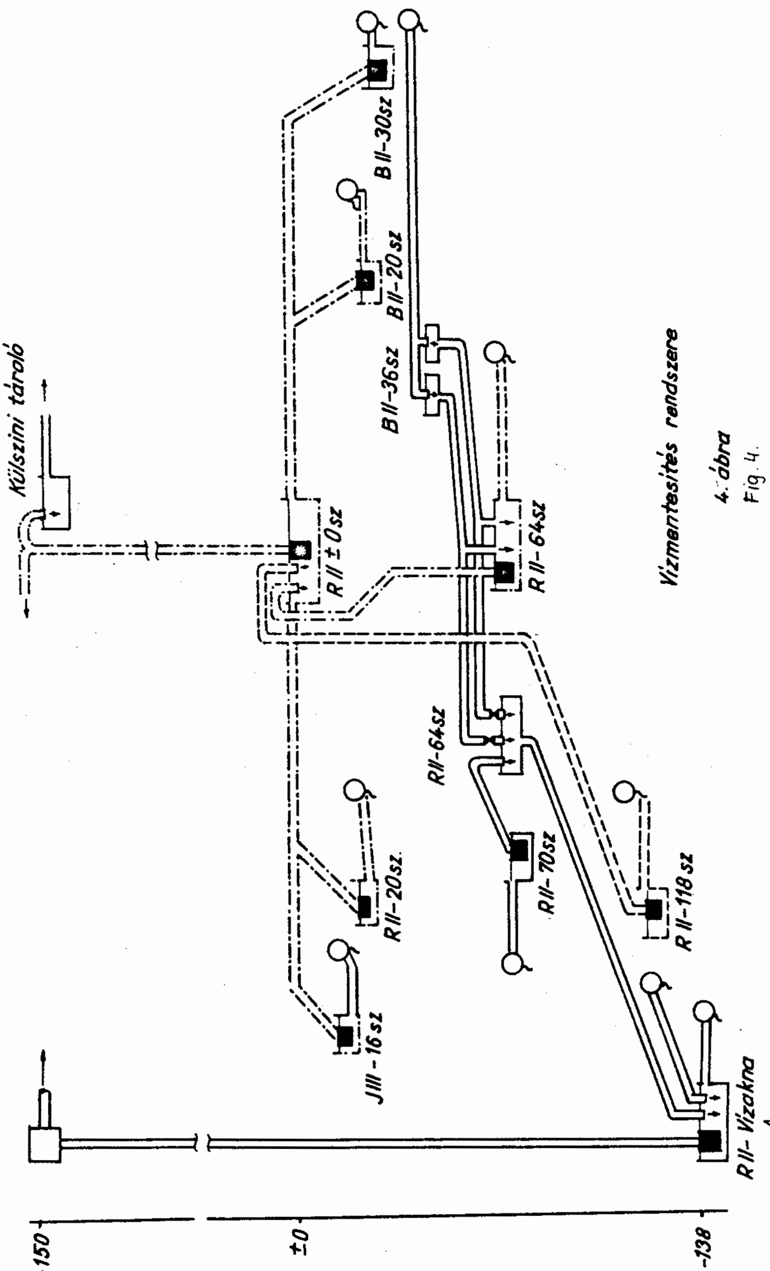
Fig. 3.



Vízmentesítés rendszere

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Fig. 4.